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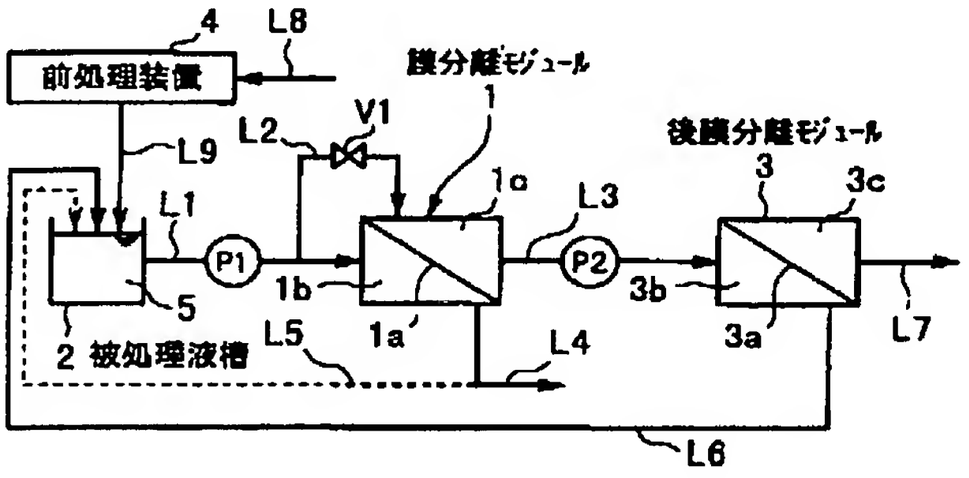
(54)【発明の名称】　膜分離方法および装置

(57)【要約】
【課題】　入手および処分が容易な浸透圧液および小型の装置を用いて、低い操作圧で効率よく膜分離を行い、低エネルギー量で高濃度の濃縮液を得ることができる膜分離方法および装置を提供する。
【解決手段】　前処理装置４で前処理した被処理液５を加圧ポンプＰ１で膜分離モジュール１の濃縮室１ｂに供給し、半透膜１ａを通して膜分離を行う際、被処理液の一部を浸透圧液路Ｌ２から透過室１ｃに供給して、浸透圧の差を小さくし、これによりポンプ圧の低い状態で高濃度の濃縮液を得、透過液は後膜分離モジュール３で膜分離し、濃縮液を被処理液槽２に戻す。



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【特許請求の範囲】
【請求項１】　半透膜の片側に形成された濃縮室に被処理液を供給し、
反対側に形成された透過室に被処理液を含む浸透圧液を供給し、
濃縮室側から溶媒を透過室側に透過させて膜分離を行うことを特徴とする膜分離方法。
【請求項２】　被処理液を濃縮室と透過室の両方に供給する請求項１記載の方法。
【請求項３】　前膜分離による濃縮液を被処理液として供給して膜分離する請求項１または２記載の方法。
【請求項４】　透過室から得られる透過液を後膜分離し、その濃縮液を被処理液に混合して膜分離する請求項１ないし３のいずれかに記載の方法。
【請求項５】　半透膜により濃縮室および透過室を区画した膜分離モジュールを複数段設け、前段の濃縮液を後段の被処理液および浸透圧液として供給する請求項１ないし４のいずれかに記載の方法。
【請求項６】　半透膜の片側に形成される濃縮室および反対側に形成される透過室と、
濃縮室に被処理液を供給する被処理液路と、
透過室に被処理液を含む浸透圧液を供給する浸透圧液路と、
濃縮室の圧力を透過室の圧力よりも高くする差圧形成手段と、
濃縮室から濃縮液を取り出す濃縮液路と、
透過室から透過液を取り出す透過液路とを含む膜分離装置。
【請求項７】　被処理液路から浸透圧液路に被処理液を分流する分流路を有する請求項６記載の装置。
【請求項８】　低濃度液を濃縮し、その濃縮液を被処理液として供給する前膜分離装置を有する請求項６または７記載の方法。
【請求項９】　透過室から得られる透過液を濃縮し、その濃縮液を被処理液に混合する後膜分離装置を有する請求項６ないし８のいずれかに記載の装置。
【請求項１０】　半透膜により濃縮室および透過室を区画した複数段の膜分離モジュールと、前段の膜分離モジュールの濃縮液を後段の膜分離モジュールの被処理液および浸透圧液として供給する供給流路を含む請求項６ないし９のいずれかに記載の装置。
【発明の詳細な説明】
【０００１】
【発明の属する技術分野】本発明は半透膜を用いる膜分離方法および装置、特に高濃縮液に適した膜分離方法および装置に関するものである。
【０００２】
【従来の技術】半透膜を通して溶媒を移動させ、被処理液を濃縮するとともに透過液を得る膜分離方法が採用されている。半透膜により溶液とその溶媒を隔てると、溶

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媒は浸透圧により溶液側に透過する。このため溶液を濃縮するためには、溶液側を加圧することにより浸透圧に抗して溶媒を透過させる必要がある。このような膜分離方法は逆浸透（ＲＯ）と呼ばれ、これに用いられる半透膜は逆浸透膜と呼ばれている。通常逆浸透は溶液中の塩分を濃縮する場合に用いられているが、浸透圧は塩分以外の溶質が溶解した溶液にも生じるから、塩分以外の溶質が溶解した一般の溶液を濃縮する場合でも浸透圧が生じ、同様の原理で濃縮が行われる。
【０００３】このような膜分離による濃縮では浸透圧に抗して溶媒の透過が行われるから、浸透圧が高い被処理液の場合には操作圧を高くする必要がある。このことは被処理液を高濃縮する場合、あるいは高濃度の被処理液をさらに高濃度に濃縮する場合には高圧で膜分離を行う必要があることを意味する。ところが操作圧を高くすることは装置全体を耐圧構造かつ大型にする必要があり、加圧のためのエネルギー量も多くなり、装置の設置コストおよび運転コストが高くなるという問題点がある。また使われる膜の耐圧強度に限界があるため、濃縮限界が生じる。
【０００４】このような点を改善し、低い操作圧で高濃縮を行う膜分離方法として、透過液側に浸透圧液を流して膜分離を行う方法が提案されている（特開平４－２１５８２２号）。この方法は被処理液とは異なる液であって浸透圧を有する液を透過液側に流すことにより、浸透圧の差よりも若干高い操作圧で膜分離して高濃縮することを可能にする。すなわち被処理液より浸透圧の高い浸透圧液を流すと、被処理液側を加圧しなくても被処理液側から溶媒が透過するが、被処理液より低い浸透圧液を流す場合でも、両者の浸透圧の差よりも若干高い圧力で被処理液を流すことにより、被処理液側から溶媒が透過して膜分離が行われる。従って吐出圧が低い小型のポンプを使用し、耐圧容器を用いることなく膜分離を行って高濃縮することが可能になる。
【０００５】しかしながらこのような従来の方法では、溶媒によって希釈された大量の浸透圧液が生成し、その処分は困難であった。海水のように入手および処分が容易な浸透圧液を利用する場合はあまり問題はないが、この液を利用するには立地条件に制限を受ける。またこのような液でも浸透圧液として利用するためには、膜分離装置に悪影響を与えないような前処理をする必要があり、またそのままで廃棄できない場合には後処理が必要になるなどの問題点があった。
【０００６】
【発明が解決しようとする課題】本発明の課題は、入手および処分が容易な浸透圧液および小型の装置を用いて、低い操作圧で効率よく膜分離を行い、低エネルギー量で高濃度の濃縮液を得ることができる膜分離方法および装置を提供することである。
【０００７】

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【課題を解決するための手段】本発明は次の膜分離方法および装置である。

（１）　半透膜の片側に形成された濃縮室に被処理液を供給し、反対側に形成された透過室に被処理液を含む浸透圧液を供給し、濃縮室側から溶媒を透過室側に透過させて膜分離を行うことを特徴とする膜分離方法。

（２）　被処理液を濃縮室と透過室の両方に供給する上記（１）記載の方法。

（３）　前膜分離による濃縮液を被処理液として供給して膜分離する上記（１）または（２）記載の方法。

（４）　透過室から得られる透過液を後膜分離し、その濃縮液を被処理液に混合して膜分離する上記（１）ないし（３）のいずれかに記載の方法。

（５）　半透膜により濃縮室および透過室を区画した膜分離モジュールを複数段設け、前段の濃縮液を後段の被処理液および浸透圧液として供給する上記（１）ないし（４）のいずれかに記載の方法。

（６）　半透膜の片側に形成される濃縮室および反対側に形成される透過室と、濃縮室に被処理液を供給する被処理液路と、透過室に被処理液を含む浸透圧液を供給する浸透圧液路と、濃縮室の圧力を透過室の圧力よりも高くする差圧形成手段と、濃縮室から濃縮液を取り出す濃縮液路と、透過室から透過液を取り出す透過液路とを含む膜分離装置。

（７）　被処理液路から浸透圧液路に被処理液を分流する分流路を有する上記（６）記載の装置。

（８）　低濃度液を濃縮し、その濃縮液を被処理液として供給する前膜分離装置を有する上記（６）または（７）記載の方法。

（９）　透過室から得られる透過液を濃縮し、その濃縮液を被処理液に混合する後膜分離装置を有する上記（６）ないし（８）のいずれかに記載の装置。

（１０）　半透膜により濃縮室および透過室を区画した複数段の膜分離モジュールと、前段の膜分離モジュールの濃縮液を後段の膜分離モジュールの被処理液および浸透圧液として供給する供給流路を含む上記（６）ないし（９）のいずれかに記載の装置。

【０００８】本発明において膜分離の対象となる被処理液は浸透圧を示す溶液であって、溶質が溶媒に溶解した溶液であるが、不溶性物質が分散していてもよい。溶質としては無機または有機の塩類、酸、アルカリ、アルコール、糖類、蛋白質、その他の可溶性物質が含まれる。また分散性の物質であっても、親溶媒性部分が存在することにより浸透圧が表われる物質も含まれる。溶媒としてはこれらの溶質または分散質を溶解または分散させて浸透圧を示す溶液を形成できる物質があげられる。このような溶媒としては水が典型的であるが、アルコールその他の溶液であってもよい。

【０００９】本発明において膜分離に使用する半透膜は被処理液中の溶媒を透過させ、溶質の透過を阻止する膜

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である。このような半透膜としては浸透圧または逆浸透により溶媒を透過させるすべての半透膜が含まれる。通常逆浸透（ＲＯ）膜と呼ばれる半透膜は無機塩類や低分子量の有機物などを水から分離するために用いられており、本発明の半透膜に含まれる。このほかナノ濾過（ＮＦ）膜、限外濾過（ＵＦ）膜や精密濾過（ＭＦ）膜などと呼ばれる膜でも、浸透圧または逆浸透を利用して糖類や蛋白等の水溶性の高分子量物質を分離する膜は本発明の半透膜に含まれる。

【００１０】半透膜の材質としては制限はなく、酢酸セルロース、ポリアミド、ポリビニールアルコール、ポリアクリルニトリル、ポリスルホン、ニトロセルロース、トリアセチルセルロース、再生セルロース、ポリカーボネイト、ポリエーテルスルホン、２フッ化ビニリデン、４フッ化エチレン、セラミック、ポリオレフィン、ポリエチレン、ポリプロピレン、ポリイミドなど、一般に半透膜に利用されているものがすべて使用できる。このような半透膜はモジュールとして用いるのが好ましい。これらの半透膜の形状としては平膜、スパイラル、チューブラ、中空糸など任意の形状の半透膜を用いるものが使用できる。

【００１１】本発明の膜分離装置は上記の半透膜の片側に濃縮室を形成し、反対側に透過室を形成し、濃縮室に被処理液路および濃縮液路を連絡し、透過室に浸透圧液路および透過液路を連絡し、濃縮室の圧力を透過室の圧力より高くする差圧形成手段を設置して形成される。膜分離装置としては半透膜の両側に濃縮室および透過室を形成した複数のモジュールを設置するのが好ましい。これらのモジュールは半透膜により濃縮室と透過室を区画したものが好ましい。差圧形成手段としては、ポンプ等の加圧手段を用いて濃縮室に被処理液を加圧下に供給して膜分離を行い、透過室側から透過液を流出させるものが好ましいが、吸引ポンプ等の吸引手段を用いて透過室側を吸引して透過液を透過させるもの、あるいは浸透圧で透過液を透過させるものでもよい。

【００１２】浸透圧液は被処理液を含む液であり、被処理液そのものを用いてもよく、またその希釈液または濃縮液を用いてもよい。被処理液を含む浸透圧液を透過室に供給するためには、被処理液路から分流路を通して被処理液の一部を浸透圧液路に分流するのが好ましい、（濃縮室に供給する被処理液量）／（透過室に供給する被処理液量）は容量比で１／０．１～１／１０、好ましくは１／０．５～１／５程度である。透過室には被処理液以外の液を供給してもよいが、しなくてもよい。

【００１３】被処理液は同形物その他の不純物を含まないものが好ましい。このため原液が不純物を含む場合には前処理装置により不純物を除去した液を被処理液として用いるのが好ましい。前処理装置としては沈澱装置、凝集沈澱装置、濾過装置、孔径の大きい膜分離装置、殺菌装置など、除去する不純物に適した処理装置を用いる

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ことができる。前処理装置は主として半透膜の汚染ないし目詰まりを防止することを目的とすることができるが、得られる濃縮液または透過液の純度を上げる目的、その他の目的で行うこともできる。

【００１４】上記のような被処理液を供給して本発明の膜分離を行うと、濃縮室と透過室の浸透圧の差が低くなるため、小さい圧力差を与えることにより、濃縮室側から透過室側に半透膜を通して溶媒を透過させることができる。このため小型、低圧の装置を用いて、少ないエネルギー量で効率よく膜分離を行い、高濃度の被処理液についても濃縮を行い、高濃縮により、さらに高濃度の濃縮液を得ることができる。

【００１５】原液が高濃度の場合、例えば浸透圧０．９８ＭＰ（１０ｋｇｆ／ｃｍ^2）以上の場合には、原液をそのまま被処理液として本発明による膜分離を行うことができるが、原液が低濃度の場合例えば上記浸透圧未満の場合には、浸透圧液を供給しない通常の膜分離により濃縮した濃縮液を被処理液として供給し、本発明の膜分離を行うことができる。この場合、前膜分離では浸透圧液を流さないから、前処理を行った原液を排棄することなく、有効に濃縮に供することができる。

【００１６】原液が高濃度のためそのまま被処理液とし、または前処理した前処理液を被処理液として本発明の膜分離を行った場合には、透過室から得られる透過液中には被処理液を含む浸透圧液が混入している。このため前膜分離に用いたのと同様の浸透圧液を流さない通常の膜分離装置を用いた後膜分離を行い、その濃縮液を被処理液に混入して膜分離を行うのが好ましく、これにより前処理を行った被処理液を有効に利用することができる。前処理および廃棄が容易な場合には、透過液はそのまま廃棄してもよい。

【００１７】本発明では半透膜により濃縮室と透過液室を区画したモジュールを多段に設け、前段の濃縮液を次段の被処理液および浸透圧液としてそれぞれ濃縮室および透過室に供給するように流路を形成し、これにより前段の濃縮を次段の被処理液および浸透圧液として供給して膜分離を行うと、さらに高濃度にまで濃縮することができる。それぞれの段の透過液は前段の被処理液として戻すことにより、効率のよい膜分離を行うことができる。濃縮液は一般の膜分離の場合と同様に、そのまま後段に供給してもよく、また被処理液槽に循環して濃縮度を高めてから後段に送ってもよい。

【００１８】

【発明の効果】本発明によれば、被処理液を含む浸透圧液を透過室に供給して膜分離を行うことにより、入手および処分が容易な浸透圧液および小型の装置を用いて、低い操作圧で効率よく膜分離を行い、低エネルギー量で高濃度の濃縮液を得ることができる。また被処理液を濃縮室と透過室の両方に供給するようにすると、装置の構成が簡単になり、処理も容易になる。前膜分離による濃

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縮液を被処理液とすると、前処理を行った原液の利用率を高くできるとともに、低濃度の原液を効率よく膜分離することができる。後膜分離により透過液を濃縮して濃縮液を被処理液に混合して膜分離すると、高濃度の被処理液をそのまま膜分離に供することができ、被処理液の利用率を高くして処理することができる。また多段にモジュールを設置して、濃縮液を後段の被処理液および浸透圧液として供給することにより高濃縮が可能になる。

【００１９】

【発明の実施の形態】以下、本発明の実施形態を図面により説明する。図１ないし図４はそれぞれ別の実施形態を示すフロー図である。

【００２０】図１において、１は膜分離モジュールであり、半透膜１ａによって片側に濃縮室１ｂ、反対側に透過室１ｃが区画されている。２は被処理液槽であって、加圧ポンプＰ１を有する被処理液路Ｌ１が濃縮室１ｂに連絡し、これから分流する浸透圧液路Ｌ２が弁Ｖ１を介して透過室１ｃに連絡している。透過室１ｃからポンプＰ２を有する透過液路Ｌ３が後膜分離モジュール３の濃縮室３ｂに連絡している。濃縮室１ｂには濃縮液路Ｌ４が連絡し、循環式の場合には循環路Ｌ５が被処理液槽２に連絡する。後膜分離モジュール３は半透膜３ａにより濃縮室３ｂと透過室３ｃに区画されており、濃縮室３ｂから濃縮液路Ｌ６が被処理液槽２に連絡し、透過室３ｃから透過液路Ｌ７が系外に連絡している。４は前処理装置であって、原液路Ｌ８から供給される原液を前処理した前処理原液を供給する前処理原液路Ｌ９が被処理液槽２に連絡している。

【００２１】上記の膜分離装置においては、原液路Ｌ８から供給される原液を前処理装置４で前処理し、前処理原液を前処理原液路Ｌ９から被処理液槽２に送る。被処理液槽２の被処理液５は加圧ポンプＰ１により加圧して被処理液路Ｌ１から膜分離モジュール１の濃縮室１ｂに供給して膜分離を行う。このとき一部の被処理液を浸透圧液として弁Ｖ１で流量を調整しながら浸透圧液路Ｌ２から透過室１ｃに供給する。これにより半透膜１ａの両側の浸透圧の差は小さくなり、加圧ポンプＰ１の加圧力が小さい場合でも溶媒が濃縮室１ｂから半透膜１ａを透過して膜分離が行われ、被処理液は高濃度に濃縮される。濃縮室１ｂの濃縮液は濃縮液路Ｌ４が取り出され、一過式で濃縮液として系外に排出される場合と、循環路Ｌ５から被処理液槽２に循環して濃縮度をさらに高める場合とがあり、いずれの方式での運転も可能である。

【００２２】透過室１ｃの透過液は透過液路Ｌ３から取り出され、ポンプＰ２で加圧して後膜分離モジュールの濃縮室３ｂに送り、後膜分離を行う。濃縮室３ｂの濃縮液は、浸透圧液として透過室１ｃに入った被処理液と、半透膜１ａを透過した被処理液成分とが濃縮されており、濃縮液路Ｌ６から被処理液槽２に供給し、被処理液として利用する。これにより前処理を行った原液の利用

率が高くなる。透過室３ｃの透過液は透過液路Ｌ７から処理液として系外に取り出され、回収水等として利用される。上記の図１の装置は原液が比較的高濃度であって、そのまま本発明の被処理液として膜分離を行う場合に適している。

【００２３】図１において半透膜としてポリアミド製のナノろ過膜を用い、１重量%のイソプロパノール水溶液を原液とし、これを０．９８ＭＰａ（１０ｋｇ／ｃｍ^2、ゲージ圧）のポンプ操作圧で循環式にて膜分離すると、濃縮液路Ｌ４から得られる濃縮液の濃度は２重量%となり、２倍濃縮が可能となる。これに対して浸透圧液路から浸透圧液を供給しないで同条件で処理する場合の濃縮液の濃縮限界は１重量%であり、濃縮は不可能となる。

【００２４】図２は比較的低濃度の原液を処理するのに適した実施形態を示し、原液を前膜分離により濃縮して本発明の被処理液として利用するように構成されている。すなわち、６は前膜分離モジュールであって半透膜６ａにより濃縮室６ｂと透過室６ｃに区画されている。７は原液槽であって被濃縮液路Ｌ１１が加圧ポンプＰ３を介して濃縮室６ｂに連絡している。透過室６ｃには透過液路Ｌ１２が連絡している。濃縮室６ｂから濃縮液路Ｌ１３が被処理液槽２に接続し、これから分流する浸透圧液路Ｌ２が膜分離モジュール１の透過室１ｃに連絡している。透過室１ｃから透過液路Ｌ３が原液槽７に接続している。他の構成は図１と同様である。

【００２５】上記の装置による膜分離方法は、前処理装置４において前処理した前処理原液は前処理原液路Ｌ９から原液槽７に入り、被濃縮原液路Ｌ１１から加圧ポンプＰ３により加圧されて前膜分離モジュール６の濃縮室６ｂに入り前膜分離を行う。被濃縮原液中の溶媒は半透膜６ａを透過して透過室６ｃに入る。透過室６ｃには浸透圧液は供給されないので、透過液は処理液として透過液路Ｌ１２から取り出される。濃縮室６ｂの濃縮液は濃縮液路Ｌ１３から被処理液として被処理液槽２に供給し、一部は浸透圧液として浸透圧液路Ｌ２から膜分離モジュール１の透過室１ｃへ供給する。膜モジュール１における膜分離は図１の場合と同様に行われ、透過液は透過液路Ｌ３から原液槽７に供給する。これにより浸透圧液として透過室１ｃに導入した原液が希釈された透過液を前膜分離モジュールで膜分離を行って溶質を濃縮し、前処理原液の利用率を高めることができる。

【００２６】図２において半透膜として酢酸セルロース製の逆浸透膜を用いて、０．１重量%のイソプロパノール水溶液を原液とし、これを０．９８ＭＰａ（１０ｋｇ／ｃｍ^2、ゲージ圧）のポンプ操作圧で循環式にて膜分離すると、濃縮液路Ｌ４から得られる濃縮液の濃度は２重量%となり、２０倍濃縮が可能となる。これに対して浸透圧液路から浸透圧液を供給しないで同条件で処理する場合の濃縮液の濃度は１重量%であり、１０倍濃縮となる。

【００２７】図３は図１の装置を多段に構成した実施形態を示す。１１は第２膜分離モジュールであって、半透膜１１ａにより濃縮室１１ｂと透過室１１ｃが区画されている。１２は第２被処理液槽であって、加圧ポンプＰ４を有する被処理液路Ｌ２１が第２膜分離モジュール１１の濃縮室１１ｂに連絡している。膜分離モジュール１の濃縮液路Ｌ４は第２被処理液槽１２に連絡し、これから分流する浸透圧液路Ｌ２２が第２膜分離モジュール１１の透過液室１１ｃに連絡している。透過室１１ｃから透過液路Ｌ２３が被処理液槽２に接続している。濃縮液室１１ｂには濃縮液路Ｌ２４が連絡しており、循環式の場合には循環路Ｌ２５が第２被処理液槽１２に連絡する。

【００２８】上記の装置による膜分離方法は、図１の場合と同様に行われるが、多段に膜分離を行うことにより濃縮度をさらに高めることができる。すなわち膜分離モジュール１の濃縮液は濃縮液路Ｌ４から取り出してその一部を被処理液として第２被処理液槽１２に導入し、一部は浸透圧液として浸透圧液路Ｌ２２から第２膜分離モジュール１１の透過室１１ｃに送る。第２被処理液槽１２の被処理液１５は加圧ポンプＰ４により加圧して被処理液路Ｌ２１から第２膜分離モジュール１１の濃縮室１１ｂに供給して膜分離を行う。ここでは膜分離モジュール１の場合と同様に膜分離が行われ、被処理液は濃縮される。濃縮液は濃縮液路Ｌ２４から取り出され一過式の場合はそのまま排出され、さらに多段の膜分離を行う場合は後段に送られる。循環式の場合は循環路Ｌ２５から第２被処理液槽１２に循環する。透過液は透過液路Ｌ２３から被処理液槽２に供給する。

【００２９】図３において半透膜としてポリアミド製のナノろ過膜を用い、０．１重量%のショ糖水溶液を原液とし、これを０．９８ＭＰａ（１０ｋｇ／ｃｍ^2、ゲージ圧）のポンプ操作圧で循環式にて膜分離すると、濃縮液路Ｌ２４から得られる濃縮液の濃度は３重量%となり、３０倍濃縮が可能となる。これに対して浸透圧液路から浸透圧液を供給しないで同条件で処理する場合の濃縮液の濃度は１重量%であり、１０倍濃縮となる。

【００３０】図４は図２の装置を多段に構成した実施形態を示す。基本的な構成は図２と同様であるが、第２膜分離モジュール１１および第２被処理液槽１２の構成は図３と同様であり、図３と同様に膜分離モジュール１に接続している。上記の装置における膜分離は基本的には図２の場合と同様に行われるが、第２膜分離装置モジュール１１における膜分離は図３の場合と同様に行われる。

【００３１】図４において半透膜としてポリアミド製の逆浸透膜を用い、０．２重量%の食塩水溶液を原液とし、これを１．４７ＭＰａ（１５ｋｇ／ｃｍ^2、ゲージ圧）のポンプ操作圧で循環式にて膜分離すると、濃縮液

路Ｌ２４から得られる濃縮液の濃度は３重量%となり、１５倍濃縮が可能となる。これに対して浸透圧液路から浸透圧液を供給しないで同条件で処理する場合の濃縮液の濃度は１重量%であり、５倍濃縮となる。

【００３２】図３、図４の装置において、さらに膜分離モジュールを増やして多段に処理を行うと、より加圧力を低くして、高濃度に濃縮を行うことができる。上記各実施形態において、膜分離モジュールおよび流路の構成は任意に変更可能である。また差圧形成手段として加圧ポンプを用いたが、吸引ポンプでもよく、また場合によっては浸透圧を利用するものでもよい。

【図面の簡単な説明】

【図１】実施形態の膜分離装置のフロー図である。

【図２】他の実施形態の膜分離装置のフロー図である。

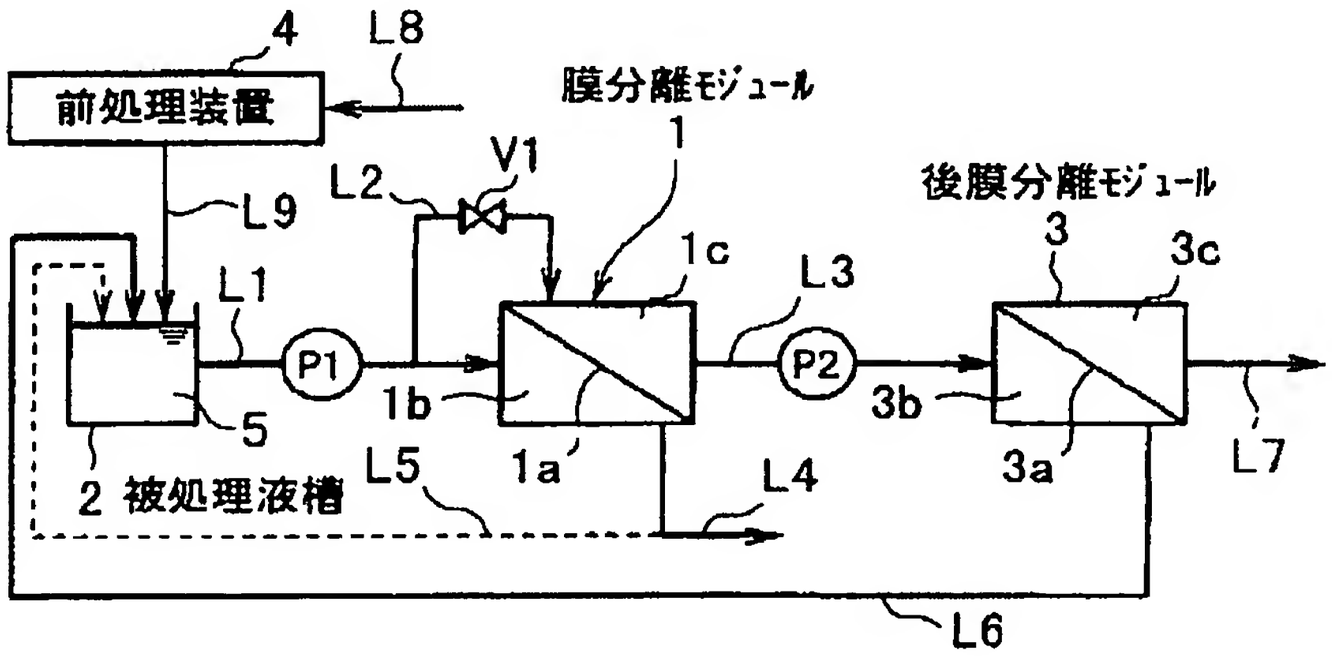
【図３】さらに他の実施形態の膜分離装置のフロー図である。

【図４】さらに他の実施形態の膜分離装置のフロー図である。

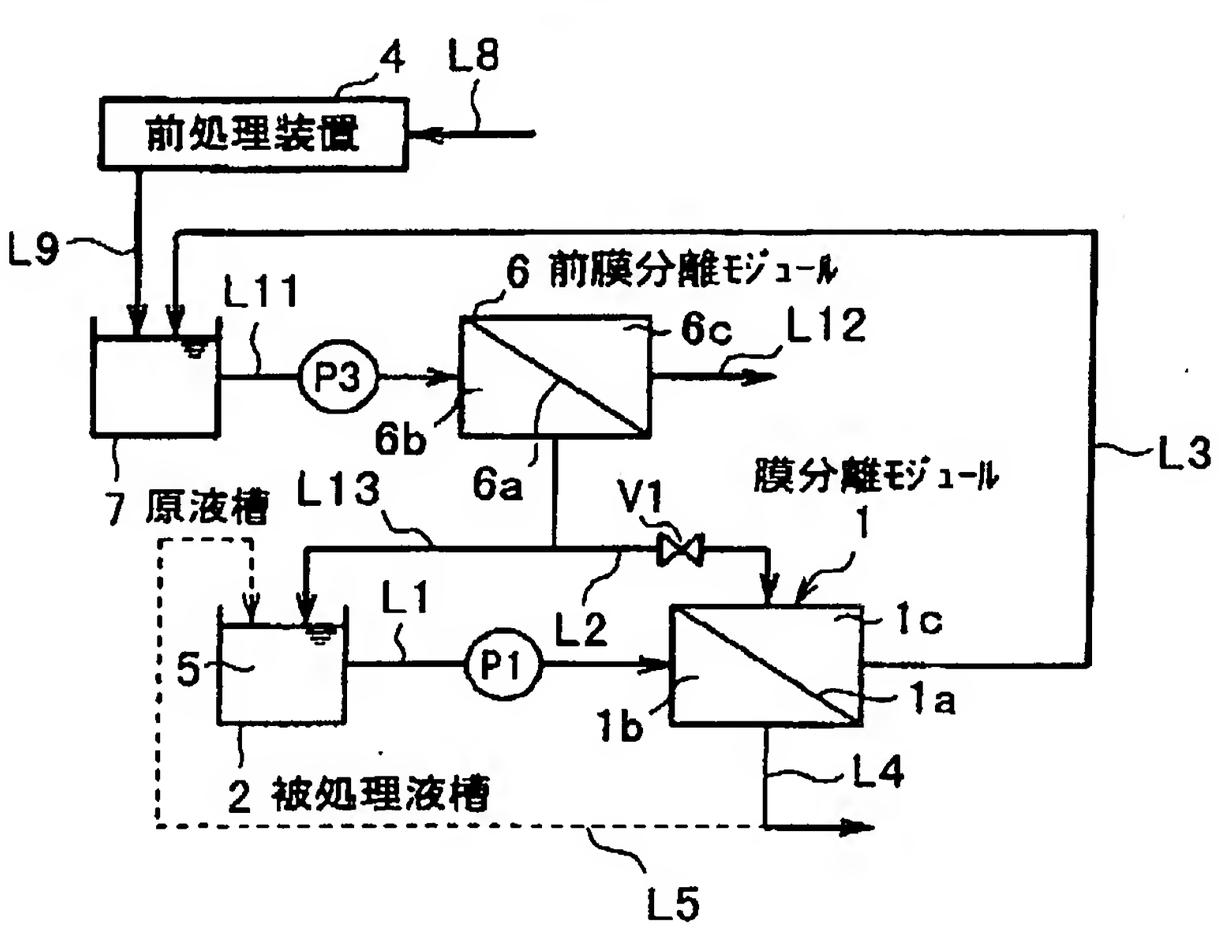
【符号の説明】

１　膜分離モジュール
２　被処理液槽
３　後膜分離モジュール
４　前処理装置
５、１５　被処理液
６　前膜分離モジュール
７　原液槽
１１　第２膜分離モジュール
１２　第２被処理液槽

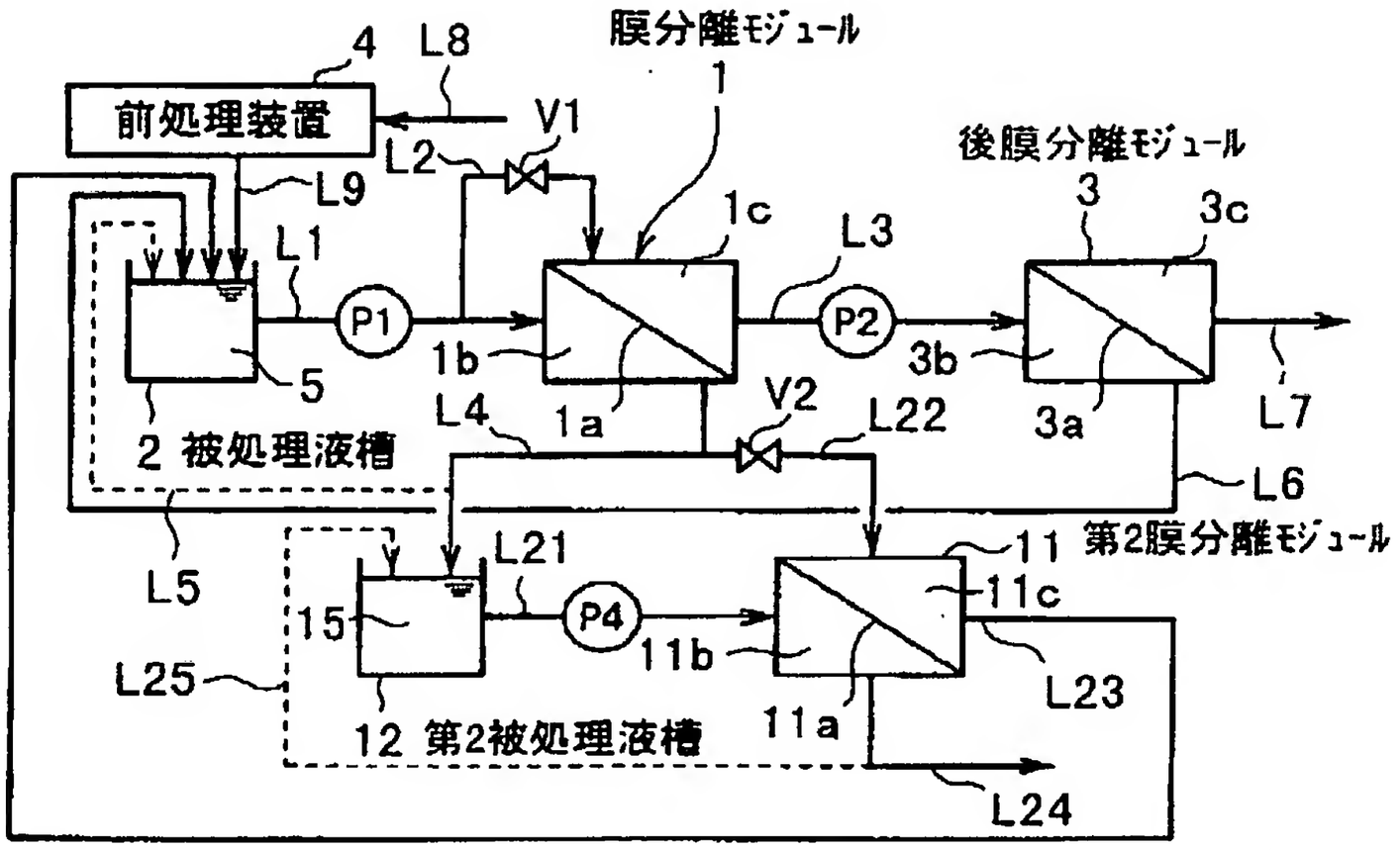
【図１】



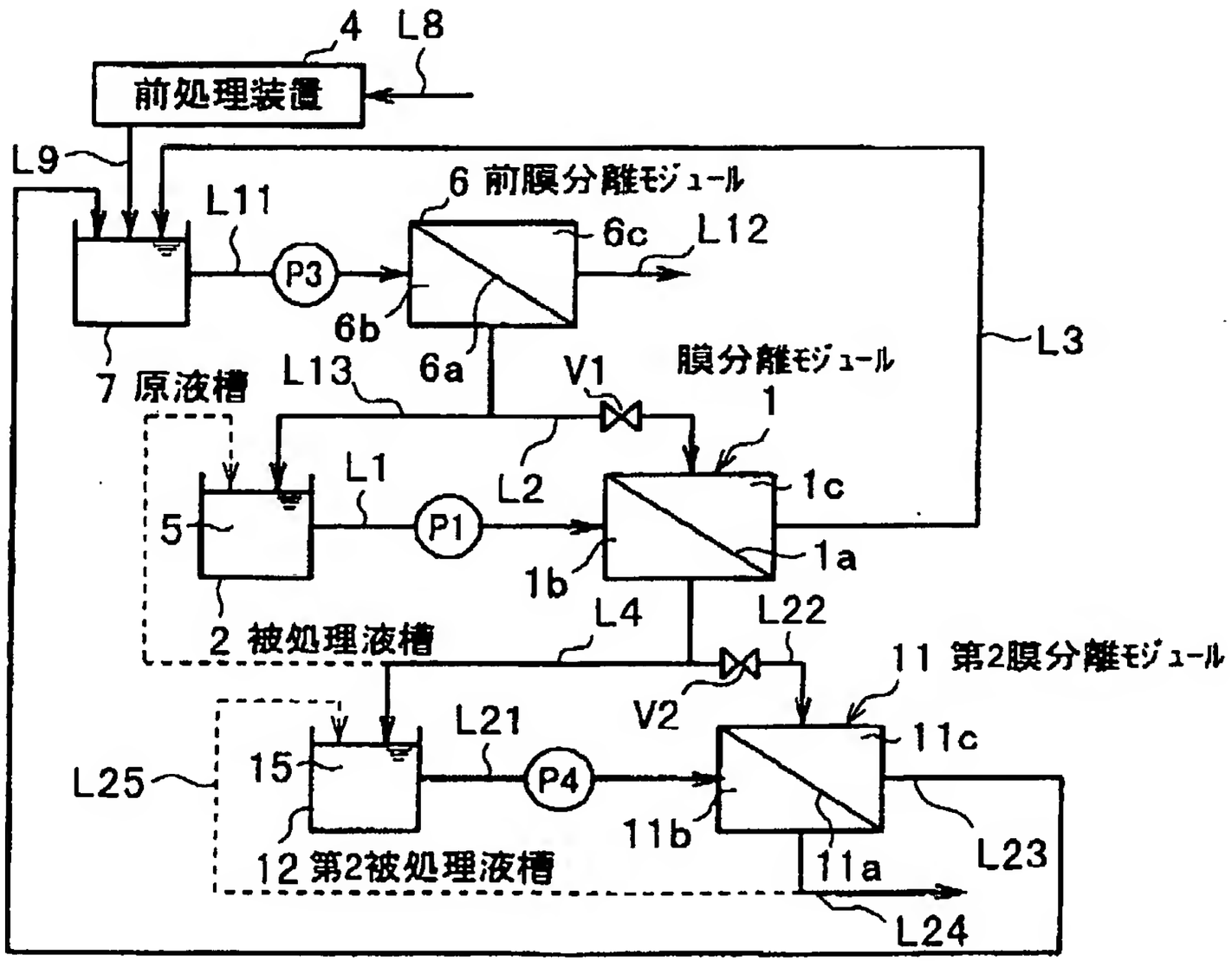
【図２】



【図３】


膜分離モジュール
1
4
L8
前処理装置
V1
L2
後膜分離モジュール
3
3c
L9
1c
L3
L1
P1
P2
1b
3b
5
V2
L22
L4
1a
3a
L7
2 被処理液槽
L6
L21
11
第2膜分離モジュール
L5
11c
15
P4
11b
L25
L23
12 第2被処理液槽
11a
L24

【図４】


4
L8
前処理装置
L9
6 前膜分離モジュール
L11
6c
L12
P3
6b
6a
L3
7 原液槽
L13
V1
膜分離モジュール
1
L1
L2
1c
5
P1
1b
1a
L4
L22
2 被処理液槽
11 第2膜分離モジュール
V2
L21
11c
L25
15
P4
11b
L23
12 第2被処理液槽
11a
L24

フロントページの続き

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MA02 MA03 MA04 MC12 MC18
MC23 MC29 MC30 MC33 MC39
MC45 MC49 MC54X MC62
PA02 PB12 PB25 PB26 PB32
PB52

PATENT ABSTRACTS OF JAPAN

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(71)Applicant : KURITA WATER IND LTD
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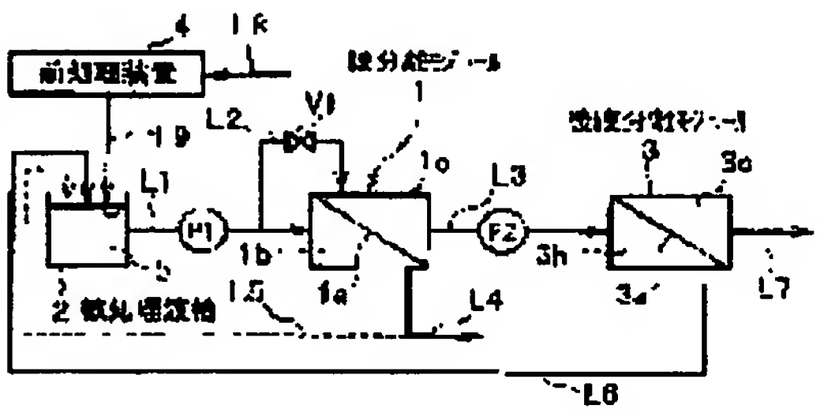
(54) METHOD AND APPARATUS FOR MEMBRANE SEPARATION

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a membrane separation method which uses an osmotic pressure solution easy of acquisition and disposal and a small-size apparatus, performs membrane separation efficiently at a low operation pressure, and can obtain a high concentration solution with energy saved, and an apparatus for the method.
SOLUTION: When liquid 5 to be treated which was pre-treated by a pre- treatment apparatus 4 is supplied to the concentration chamber 1b of a membrane separation module 1 by a pressure pump P1 and membrane-separated through a semipermeable membrane 1a, a part of the liquid is supplied from an osmotic pressure solution passage L2 to a permeation chamber 1c, the difference in osmotic pressure is reduced, a high concentration solution is obtained with the pressure of the pump reduced, the filtrate is membrane-separated with a post-membrane separation module 3, and the concentrated solution is returned to a treatment liquid tank 2.



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[Date of final disposal for application]

[Patent number]

[Date of registration]

[Number of appeal against examiner's decision of rejection]

[Date of requesting appeal against examiner's decision of rejection]

[Date of extinction of right]

* NOTICES *

1.This document has been translated by computer. So the translation may not reflect the original precisely.
2.**** shows the word which can not be translated.
3.In the drawings, any words are not translated.

CLAIMS

[Claim(s)]
[Claim 1] The membrane-separation approach characterized by supplying a processed liquid to the concentration room formed in one side of semipermeable membrane, supplying the osmotic-pressure liquid containing a processed liquid to the transparency room formed in the opposite hand, making a solvent penetrate from a concentration room side to a transparency room side, and performing membrane separation.
[Claim 2] The approach according to claim 1 of supplying a processed liquid to both a concentration room and a transparency room.
[Claim 3] The approach according to claim 1 or 2 of supplying the concentration liquid by before membrane separation as a processed liquid, and carrying out membrane separation.
[Claim 4] The approach according to claim 1 to 3 of carrying out after membrane separation of the permeate liquid obtained from a transparency room, and mixing and carrying out membrane separation of the concentration liquid to a processed liquid.
[Claim 5] The approach according to claim 1 to 4 of preparing two or more steps of membrane-separation modules which divided the concentration room and the transparency room by semipermeable membrane, and supplying the concentration liquid of the preceding paragraph as a latter processed liquid and osmotic-pressure liquid.
[Claim 6] A membrane separation device including the transparency room formed in the concentration room and the opposite hand formed in one side of semipermeable membrane, the processed liquid way which supplies a processed liquid to a concentration room, the osmotic-pressure liquid route which supplies the osmotic-pressure liquid containing a processed liquid to a transparency room, the differential-pressure means forming which makes the pressure of a concentration room higher than the pressure of a transparency room, the concentration liquid route which takes out concentration liquid from a concentration room, and the permeate-liquid way which takes out permeate liquid from a transparency room.
[Claim 7] Equipment according to claim 6 which has the part passage which carries out the diversion of river of the processed liquid to an osmotic-pressure liquid route from a processed liquid way.
[Claim 8] The method according to claim 6 or 7 of having a membrane separation device, before condensing low concentration liquid and supplying the concentration liquid as a processed liquid.
[Claim 9] Equipment according to claim 6 to 8 which has a membrane separation device after condensing the permeate liquid obtained from a transparency room and mixing the concentration liquid to a processed liquid.
[Claim 10] Equipment including the supply passage which supplies the concentration liquid of two or more steps of membrane-separation modules which divided the concentration room and the transparency room by semipermeable membrane, and the membrane-separation module of the preceding paragraph as the latter processed liquid and the osmotic-pressure liquid of a membrane-separation module according to claim 6 to 9.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the membrane-separation approach and equipment suitable for the membrane-separation approach of using semipermeable membrane and equipment, especially high concentration liquid.
[0002]
[Description of the Prior Art] A solvent is moved through semipermeable membrane, and while condensing a processed liquid, the membrane-separation approach of obtaining permeate liquid is adopted. If a solution and its solvent are separated by semipermeable membrane, a solvent will be penetrated to a solution side with osmotic pressure. For this reason, in order to condense a solution, it is necessary to resist osmotic pressure and to make a solvent penetrate by pressurizing a solution side. Such a membrane-separation approach is called reverse osmosis (RO), and the semipermeable membrane used for this is called the reverse osmotic membrane. Usually, although it is used when reverse osmosis condenses the salinity in a solution, since it is generated also in the solution which solutes other than salinity dissolved, even when condensing the common solution which solutes other than salinity dissolved, osmotic pressure produces osmotic pressure, and concentration is performed by the same principle.
[0003] In concentration by such membrane separation, since osmotic pressure is resisted and transparency of a solvent is performed, to be a processed liquid with high osmotic pressure, it is necessary to make operating pressure high. This means that it is necessary to perform membrane separation with high voltage, when carrying out high concentration of the processed liquid, or when condensing a high-concentration processed liquid to high concentration further. However, in the whole equipment, it is necessary to make it large-sized, the amount of energy for application of pressure also increases, and making operating pressure high has proof-pressure structure and the trouble that the installation cost and operation cost of equipment become high. Moreover, since a limitation is in the pressure resistance of the film used, a concentration limitation is generated.
[0004] Such a point is improved and the method of pouring osmotic-pressure liquid and performing membrane separation to a permeate liquid side as the membrane-separation approach of performing high concentration by low operating pressure, is proposed (JP,4-215822,A). A processed liquid is different liquid and this approach makes it possible to carry out membrane separation and to carry out high concentration by operating pressure [a little] higher than the difference of osmotic pressure, by pouring the liquid which has osmotic pressure to a permeate liquid side. That is, if osmotic-pressure liquid with osmotic pressure higher than a processed liquid is poured, even if it does not pressurize a processed liquid side, a solvent will penetrate from a processed liquid side, but even when pouring osmotic-pressure liquid lower than a processed liquid, by passing a processed liquid by the pressure [a little] higher than the difference of both osmotic pressure, a solvent penetrates from a processed liquid side and membrane separation is performed. Therefore, it becomes possible to perform membrane separation and to carry out high concentration, without using a small pump with a low discharge pressure, and using a proof-pressure container.
[0005] However, the osmotic-pressure liquid of the large quantity diluted with such a conventional approach with the solvent generated, and the disposal was difficult. Although it is almost satisfactory when acquisition and disposal use easy osmotic-pressure liquid like seawater, for using this liquid, a limit is received in a site condition. Moreover, in order to also use such liquid as osmotic-pressure liquid, pretreatment which does not have an adverse effect on a membrane separation device needed to be carried out, and when it remained as it is and was not able to discard, there were troubles, like after treatment is needed.
[0006]
[Problem(s) to be Solved by the Invention] It is offering the membrane-separation approach and equipment which the technical problem of this invention can perform membrane separation efficiently by low operating pressure using osmotic-pressure liquid with easy acquisition and disposal, and small equipment, and can obtain the high-concentration concentration liquid in the amount of low energy.
[0007]
[Means for Solving the Problem] This inventions are the following membrane-separation approach and equipment.
(1) The membrane-separation approach characterized by supplying a processed liquid to the concentration room formed in one side of semipermeable membrane, supplying the osmotic-pressure liquid containing a processed liquid to the transparency room formed in the opposite hand, making a solvent penetrate from a concentration room side to a transparency room side, and performing membrane separation.

(2) The approach of the above-mentioned (1) publication which supplies a processed liquid to both a concentration room and a transparency room.
(3) An approach the above (1) which supplies the concentration liquid by before membrane separation as a processed liquid, and carries out membrane separation, or given in (2).
(4) An approach the above (1) which carries out after membrane separation of the permeate liquid obtained from a transparency room, and mixes and carries out membrane separation of the concentration liquid to a processed liquid thru/or given in either of (3).
(5) An approach the above (1) which prepares two or more steps of membrane-separation modules which divided the concentration room and the transparency room by semipermeable membrane, and supplies the concentration liquid of the preceding paragraph as a latter processed liquid and osmotic-pressure liquid thru/or given in either of (4).
(6) A membrane separation device including the transparency room formed in the concentration room and the opposite hand formed in one side of semipermeable membrane, the processed liquid way which supplies a processed liquid to a concentration room, the osmotic-pressure liquid route which supplies the osmotic-pressure liquid containing a processed liquid to a transparency room, the differential-pressure means forming which makes the pressure of a concentration room higher than the pressure of a transparency room, the concentration liquid route which takes out concentration liquid from a concentration room, and the permeate-liquid way which takes out permeate liquid from a transparency room.
(7) Equipment of the above-mentioned (6) publication which has the part passage which carries out the diversion of river of the processed liquid to an osmotic-pressure liquid route from a processed liquid way.
(8) An approach the above (6) which has a membrane separation device before condensing low concentration liquid and supplying the concentration liquid as a processed liquid, or given in (7).
(9) Equipment the above (6) which has a membrane separation device after condensing the permeate liquid obtained from a transparency room and mixing the concentration liquid to a processed liquid thru/or given in either of (8).
(10) Equipment the above (6) including the supply passage which supplies the concentration liquid of two or more steps of membrane-separation modules which divided the concentration room and the transparency room by semipermeable membrane, and the membrane-separation module of the preceding paragraph as the latter processed liquid and the osmotic-pressure liquid of a membrane-separation module thru/or given in either of (9).
[0008] Although the processed liquid set as the object of membrane separation in this invention is a solution in which osmotic pressure is shown and it is the solution which the solute dissolved in the solvent, the insoluble matter may be distributing. As a solute, inorganic or organic salts, an acid, alkali, alcohol, a saccharide, protein, and other fusibility matter are contained. Moreover, even if it is the matter of dispersibility, when a parent solvent nature part exists, the matter with which osmotic pressure appears is also contained. The matter which can form the solution in which these solutes or dispersoids are dissolved or distributed as a solvent, and osmotic pressure is shown is raised. Although water is typical as such a solvent, you may be the solution of alcohol and others.
[0009] The semipermeable membrane used for membrane separation in this invention is film which is made to penetrate the solvent in a processed liquid and prevents transparency of a solute. All the semipermeable membrane that makes a solvent penetrate by osmotic pressure or reverse osmosis as such semipermeable membrane is contained. Usually, the semipermeable membrane called the reverse osmosis (RO) film is used in order to separate mineral, the organic substance of low molecular weight, etc. from water, and it is contained in the semipermeable membrane of this invention. In addition, the film with which the film called the nano filtration (NF) film, the ultrafiltration (UF) film, the precision filtration (MF) film, etc. also separates the water-soluble amount matter of macromolecules, such as a saccharide and protein, using osmotic pressure or reverse osmosis is contained in the semipermeable membrane of this invention.
[0010] As construction material of semipermeable membrane, there is no limit and all the things generally used for semipermeable membrane can use cellulose acetate, a polyamide, poly vinyl alcohol, the poly acrylic nitril, polysulfone, a nitrocellulose, triacetyl cellulose, a regenerated cellulose, a polycarbonate, polyether sulphone, 2 vinylidene fluorides, ethylene tetrafluoride, a ceramic, polyolefine, polyethylene, polypropylene, polyimide, etc. As for such semipermeable membrane, using as a module is desirable. The thing using semipermeable membrane of the configuration of arbitration, such as a flat film, a spiral, tubular one, and a hollow filament, as a configuration of such semipermeable membrane can be used.
[0011] A concentration room is formed in one side of the above-mentioned semipermeable membrane, a transparency room is formed in an opposite hand, and the membrane separation device of this invention connects a processed liquid way and a concentration liquid route to a concentration room, connects an osmotic-pressure liquid route and a permeate liquid way to a transparency room, it installs the differential pressure means forming which makes the pressure of a concentration room higher than the pressure of a transparency room, and is formed. It is desirable to install two or more modules which formed the concentration room and the transparency room in the both sides of semipermeable membrane as a membrane separation device. As for these modules, what divided the concentration room and the transparency room by semipermeable membrane is desirable. Although the thing which a processed liquid is supplied [thing] to the bottom of application of pressure, and membrane separation is performed [thing] in a concentration room, and makes permeate liquid flow into it out of a transparency room side, using application-of-pressure means, such as a pump, as differential pressure means forming is desirable, permeate liquid may be made to penetrate with the thing which a transparency room side is attracted [thing] using attraction means, such as a suction pump, and makes permeate liquid penetrate, or osmotic pressure.

[0012] Osmotic-pressure liquid is the liquid containing a processed liquid, may use the processed liquid itself and may use the diluent or concentration liquid. (amount of processed liquids supplied to concentration room)/(the amount of processed liquids supplied to a transparency room) with desirable in order to supply the osmotic-pressure liquid containing a processed liquid to a transparency room carrying out the diversion of river of a part of processed liquid to an osmotic-pressure liquid route through a diversion-of-river way from a processed liquid way -- a capacity factor -- 1 / 0.1 - 1/10 -- it is about 1 / 0.5 to 1/5 preferably. Although liquid other than a processed liquid may be supplied to a transparency room

[0013] As for a processed liquid, what does not contain the impurity of an isomorphism object and others is desirable. For this reason, when an undiluted solution contains an impurity, it is desirable to use the liquid from which the impurity was removed with the pre-treatment equipment as a processed liquid. As a pre-treatment equipment, processors suitable for the impurity to remove, such as precipitation equipment, flocculator, a filter, a large membrane separation device of an aperture, and a sterilizer, can be used. Although a pre-treatment equipment can be aimed at mainly preventing contamination thru/or blinding of semipermeable membrane, it can also be performed for the object which raises the purity of the concentration liquid obtained or permeate liquid, and the other object.

[0014] If the above processed liquids are supplied and membrane separation of this invention is performed, since the difference of the osmotic pressure of a concentration room and a transparency room will become low, a solvent can be made to penetrate from a concentration room side through semipermeable membrane by giving a small pressure differential to a transparency room side. For this reason, using small and low-pressure equipment, membrane separation can be efficiently performed in the small amount of energy, it can condense also about a high-concentration processed liquid, and further high-concentration concentration liquid can be obtained by high concentration.

[0015] When an undiluted solution is high concentration (for example, when it is more than osmotic-pressure 0.98MP (10 kgf/cm2)), membrane separation by this invention can be performed by making an undiluted solution into a processed liquid as it is, but when an undiluted solution is low concentration (for example, when it is under the above-mentioned osmotic pressure), the concentration liquid condensed by the usual membrane separation which does not supply osmotic-pressure liquid can be supplied as a processed liquid, and membrane separation of this invention can be performed. In this case, in before membrane separation, concentration can be presented effectively, without eliminating the undiluted solution which pretreated, since osmotic-pressure liquid is not poured.

[0016] Since an undiluted solution is high concentration, when membrane separation of this invention is performed by making into a processed liquid the pretreatment liquid which made the processed liquid as it was, or was pretreated, into the permeate liquid obtained from a transparency room, the osmotic-pressure liquid containing a processed liquid is mixing. For this reason, it is desirable to perform membrane separation, after using the usual membrane separation device which does not pour the osmotic-pressure liquid same with having used for before membrane separation, to mix that concentration liquid in a processed liquid, and to perform membrane separation, and it can use effectively the processed liquid which pretreated by this. When pretreatment and abolition are easy, permeate liquid may be discarded as it is.

[0017] In this invention, the module which divided the concentration room and the permeate liquid room by semipermeable membrane is prepared in multistage, passage is formed so that the concentration liquid of the preceding paragraph may be supplied to a concentration room and a transparency room as the processed liquid and osmotic-pressure liquid of the next step, respectively, and if this supplies concentration of the preceding paragraph as the processed liquid and osmotic-pressure liquid of the next step and membrane separation is performed, it can condense even to high concentration further. By returning as a processed liquid of the preceding paragraph, the permeate liquid of each stage can perform efficient membrane separation. After supplying concentration liquid to the latter part as it is, and circulating through it to a processed liquid tub like the case of general membrane separation and raising enrichment, it may be sent to the latter part.

[0018]

[Effect of the Invention] By supplying the osmotic-pressure liquid containing a processed liquid to a transparency room, and performing membrane separation, using easy osmotic-pressure liquid and small equipment, acquisition and disposal can perform membrane separation efficiently by low operating pressure, and, according to this invention, can obtain the high-concentration concentration liquid in the amount of low energy. Moreover, if a processed liquid is supplied to both a concentration room and a transparency room, the configuration of equipment will become easy and processing will also become easy. If the concentration liquid by before membrane separation is made into a processed liquid, while being able to make the utilization factor of the undiluted solution which pretreated high, membrane separation of the low-concentration undiluted solution can be carried out efficiently. If permeate liquid is condensed by after membrane separation and membrane separation of the concentration liquid is mixed and carried out to a processed liquid, membrane separation can be presented with a high-concentration processed liquid as it is, and the utilization factor of a processed liquid can be made high and can be processed. Moreover, a module is installed in multistage and high concentration is attained by supplying concentration liquid as a latter processed liquid and osmotic-pressure liquid.

[0019]

[Embodiment of the Invention] Hereafter, a drawing explains the operation gestalt of this invention. Drawing 1 thru/or drawing 4 are flow drawings showing a different operation gestalt, respectively.

[0020] In drawing 1 , 1 is a membrane-separation module, concentration room 1b is divided by one side, and

transparency room 1c is divided by semipermeable membrane 1a in the opposite hand. 2 is a processed liquid tub, the processed liquid way L1 which has a booster pump P1 connects it to concentration room 1b, and the osmotic-pressure liquid route L2 which will carry out a diversion of river from now on is connecting it to transparency room 1c through a valve V1. The permeate liquid way L3 which has a pump P2 from transparency room 1c is connecting with concentration room 3b of the after membrane-separation module 3. The concentration liquid route L4 connects with concentration room 1b, and in being a circuit system, a circuit L5 connects with the processed liquid tub 2. The after membrane-separation module 3 is divided by concentration room 3b and transparency room 3c by semipermeable membrane 3a, concentration room 3b to concentration liquid route L6 connects it to the processed liquid tub 2, and the permeate liquid way L7 is connecting it out of a system from transparency room 3c. 4 is a pre-treatment equipment and the pretreatment undiluted solution way L9 which supplies the pretreatment undiluted solution which pretreated the undiluted solution supplied from the undiluted solution way L8 is connecting it to the processed liquid tub 2.

[0021] In the above-mentioned membrane separation device, the undiluted solution supplied from the undiluted solution way L8 is pretreated with a pre-treatment equipment 4, and a pretreatment undiluted solution is sent to the processed liquid tub 2 from the pretreatment undiluted solution way L9. The processed liquid 5 of the processed liquid tub 2 is pressurized with a booster pump P1, is supplied to concentration room 1b of the membrane-separation module 1 from the processed liquid way L1, and performs membrane separation. Transparency room 1c is supplied from the osmotic-pressure liquid route L2, adjusting a flow rate with a valve V1 by using some processed liquids as osmotic-pressure liquid at this time. Thereby, the difference of the osmotic pressure of the both sides of semipermeable membrane 1a becomes small, even when the welding pressure of a booster pump P1 is small, a solvent penetrates concentration room 1b to semipermeable membrane 1a, membrane separation is performed, and a processed liquid is condensed by high concentration. The concentration liquid route L4 is taken out, and it circulates through the concentration liquid of concentration room 1b to the processed liquid tub 2 from the case where it is discharged out of a system as concentration liquid by the passing away formula, and a circuit L5, it may raise enrichment further, and operation with which method is also possible for it.

[0022] The permeate liquid of transparency room 1c is taken out from the permeate liquid way L3, is pressurized with a pump P2, and performs delivery and after membrane separation to concentration room 3b of an after membrane-separation module. The processed liquid which went into transparency room 1c as osmotic-pressure liquid, and the processed liquid component which penetrated semipermeable membrane 1a are condensed, and the concentration liquid of concentration room 3b is supplied to the processed liquid tub 2 from concentration liquid route L6, and is used as a processed liquid. The utilization factor of the undiluted solution which pretreated by this becomes high. The permeate liquid of transparency room 3c is taken out from the permeate liquid way L7 out of a system as processing liquid, and is used as recycled water etc. An undiluted solution is high concentration comparatively, and the equipment of above-mentioned drawing 1 is suitable when performing membrane separation as a processed liquid of this invention as it is.

[0023] If 1% of the weight of an isopropanol water solution is used as an undiluted solution using the nano filtration film made from a polyamide in drawing 1 as semipermeable membrane and membrane separation of this is carried out according to a circuit system by the pump operating pressure of 0.98MPa(s) (10kg/cm2, gage pressure), the concentration of the concentration liquid obtained from the concentration liquid route L4 will become 2 % of the weight, and 2 double concentration of it will be attained. On the other hand, the concentration limitation of the concentration liquid in the case of processing on these conditions without supplying osmotic-pressure liquid from an osmotic-pressure liquid route is 1 % of the weight, and the concentration of it becomes impossible.

[0024] Drawing 2 shows the operation gestalt suitable for processing a comparatively low-concentration undiluted solution, and it is constituted so that an undiluted solution may be condensed by before membrane separation and it may use as a processed liquid of this invention. That is, 6 is a before membrane-separation module and is divided by concentration room 6b and transparency room 6c by semipermeable membrane 6a. 7 is an undiluted solution tub and the enriched liquid route L11 is connecting it to concentration room 6b through a booster pump P3. The permeate liquid way L12 is connecting with transparency room 6c. From concentration room 6b, the concentration liquid route L13 connects with the processed liquid tub 2, and the osmotic-pressure liquid route L2 which will carry out a diversion of river from now on is connecting with transparency room 1c of the membrane-separation module 1. The permeate liquid way L3 has connected with the undiluted solution tub 7 from transparency room 1c. Other configurations are the same as that of drawing 1 .

[0025] The pretreatment undiluted solution which pretreated the membrane-separation approach by above equipment in the pre-treatment equipment 4 goes into the undiluted solution tub 7 from the pretreatment undiluted solution way L9, is pressurized with a booster pump P3 from the enriched undiluted solution way L11, goes into concentration room 6b of the before membrane-separation module 6, and performs before membrane separation. The solvent in an enriched undiluted solution penetrates semipermeable membrane 6a, and goes into transparency room 6c. Since osmotic-pressure liquid is not supplied to transparency room 6c, permeate liquid is taken out from the permeate liquid way L12 as processing liquid. The concentration liquid of concentration room 6b is supplied to the processed liquid tub 2 as a processed liquid from the concentration liquid route L13, and a part is supplied to transparency room 1c of the membrane-separation module 1 from the osmotic-pressure liquid route L2 as osmotic-pressure liquid. Membrane separation in a membrane module 1 is performed like the case of drawing 1 , and permeate liquid is supplied to the undiluted solution tub 7 from the permeate liquid way L3. A before membrane-separation module can perform membrane separation for the permeate liquid with which the undiluted solution which

this introduced into transparency room 1c as osmotic-pressure liquid was diluted, a solute can be condensed, and the utilization factor of a pretreatment undiluted solution can be raised.
[0026] If 0.1% of the weight of an isopropanol water solution is used as an undiluted solution using the reverse osmotic membrane made from cellulose acetate in drawing 2 as semipermeable membrane and membrane separation of this is carried out according to a circuit system by the pump operating pressure of 0.98MPa(s) (10kg/cm2, gage pressure), the concentration of the concentration liquid obtained from the concentration liquid route L4 will become 2 % of the weight, and concentration of it will be attained 20 times. On the other hand, the concentration of the concentration liquid in the case of processing on these conditions without supplying osmotic-pressure liquid from an osmotic-pressure liquid route is 1 % of the weight, and serves as concentration 10 times.
[0027] Drawing 3 shows the operation gestalt which constituted the equipment of drawing 1 in multistage. 11 is the 2nd membrane-separation module and concentration room 11b and transparency room 11c are divided by semipermeable membrane 11a. 12 is the 2nd processed liquid tub and the processed liquid way L21 which has a booster pump P4 is connecting it to concentration room 11b of the 2nd membrane-separation module 11. The concentration liquid route L4 of the membrane-separation module 1 is connected to the 2nd processed liquid tub 12, and the osmotic-pressure liquid route L22 which will carry out a diversion of river from now on is connecting it to permeate liquid room 11c of the 2nd membrane-separation module 11. The permeate liquid way L23 has connected with the processed liquid tub 2 from transparency room 11c. The concentration liquid route L24 is connecting with concentration liquid room 11b, and in being a circuit system, a circuit L25 connects with the 2nd processed liquid tub 12.
[0028] Although the membrane-separation approach by above equipment is performed like the case of drawing 1 , it can raise enrichment further by performing membrane separation to multistage. That is, the concentration liquid of the membrane-separation module 1 is taken out from the concentration liquid route L4, it introduces into the 2nd processed liquid tub 12 by making the part into a processed liquid, and a part is sent to transparency room 11c of the 2nd membrane-separation module 11 from the osmotic-pressure liquid route L22 as osmotic-pressure liquid. The processed liquid 15 of the 2nd processed liquid tub 12 is pressurized with a booster pump P4, is supplied to concentration room 11b of the 2nd membrane-separation module 11 from the processed liquid way L21, and performs membrane separation. Here, membrane separation is performed like the case of the membrane-separation module 1, and a processed liquid is condensed. In the case of a passing away type, concentration liquid is taken out from the concentration liquid route L24, and it is discharged as it is, and when performing multistage membrane separation further, it is sent to the latter part. In the case of a circuit system, it circulates from a circuit L25 to the 2nd processed liquid tub 12. Permeate liquid is supplied to the processed liquid tub 2 from the permeate liquid way L23.
[0029] If 0.1% of the weight of a cane-sugar water solution is used as an undiluted solution using the nano filtration film made from a polyamide in drawing 3 as semipermeable membrane and membrane separation of this is carried out according to a circuit system by the pump operating pressure of 0.98MPa(s) (10kg/cm2, gage pressure), the concentration of the concentration liquid obtained from the concentration liquid route L24 will become 3 % of the weight, and concentration of it will be attained 30 times. On the other hand, the concentration of the concentration liquid in the case of processing on these conditions without supplying osmotic-pressure liquid from an osmotic-pressure liquid route is 1 % of the weight, and serves as concentration 10 times.
[0030] Drawing 4 shows the operation gestalt which constituted the equipment of drawing 2 in multistage. Although the fundamental configuration is the same as that of drawing 2 , the configuration of the 2nd membrane-separation module 11 and the 2nd processed liquid tub 12 is the same as that of drawing 3 , and is connected to the membrane-separation module 1 like drawing 3 . Although membrane separation in above equipment is performed fundamentally like the case of drawing 2 , membrane separation in the 2nd membrane separation device module 11 is performed like the case of drawing 3 .
[0031] If 0.2% of the weight of a brine solution is used as an undiluted solution using the reverse osmotic membrane made from a polyamide in drawing 4 as semipermeable membrane and membrane separation of this is carried out according to a circuit system by the pump operating pressure of 1.47MPa(s) (15kg/cm2, gage pressure), the concentration of the concentration liquid obtained from the concentration liquid route L24 will become 3 % of the weight, and concentration of it will be attained 15 times. On the other hand, the concentration of the concentration liquid in the case of processing on these conditions without supplying osmotic-pressure liquid from an osmotic-pressure liquid route is 1 % of the weight, and serves as concentration 5 times.
[0032] In the equipment of drawing 3 and drawing 4 , if a membrane-separation module is increased further and it processes to multistage, welding pressure can be made low more and it can condense to high concentration. In each above-mentioned operation gestalt, the configuration of a membrane-separation module and passage can be changed into arbitration. Moreover, although the booster pump was used as differential pressure means forming, a suction pump is sufficient and osmotic pressure may be used depending on the case.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is flow drawing of the membrane separation device of an operation gestalt.
[Drawing 2] It is flow drawing of the membrane separation device of other operation gestalten.
[Drawing 3] It is flow drawing of the membrane separation device of the operation gestalt of further others.
[Drawing 4] It is flow drawing of the membrane separation device of the operation gestalt of further others.
[Description of Notations]
1 Membrane-Separation Module
2 Processed Liquid Tub
3 After Membrane-Separation Module
4 Pre-treatment Equipment
5 15 Processed liquid
6 Before Membrane-Separation Module
7 Undiluted Solution Tub
11 2nd Membrane-Separation Module
12 2nd Processed Liquid Tub

[Translation done.]